Chapter 32

Personality Impressions from Facial Appearance

Alexander Todorov, Christopher C. Said, and Sara C. Verosky

The study of personality inferences from facial appearance has a long history in psychology (Hollingworth, 1922; Secord, 1958; Shepherd, 1989). Work at the beginning of the 20th century was primarily focused on the accuracy of these inferences (Hollingworth, 1922; Laird, 1927; Pintner, 1918). In the fifties, the focus of research shifted to the cognitive mechanisms underlying such inferences (Secord, 1958). Subsequent social cognition research has followed this tradition with a focus on inferences of social categories (e.g. sex, age, race) and the implications of these inferences for social interaction (e.g. Eberhardt et al., 2006; Macrae et al., 2005; Quinn and Macrae, 2005). Parallel to this research, evolutionary and ecological psychologists have produced a large body of research on the determinants and consequences of facial attractiveness and facial maturity (Perrett et al., 1998; McArthur and Apatow, 1983; Montepare and Zebrowitz, 1998; Rhodes, 2006; Thornhill and Gangestad, 1993; also Penton-Voak and Morrison, Chapter 33; Zebrowitz, Chapter 3, this volume). Finally, with advances in cognitive neuroscience methods and the emergence of social neuroscience research (Adolphs, 2003), there have been multiple recent studies probing the neural correlates of personality inferences from faces (e.g. Adolphs et al., 1998; Aharon et al., 2001; Engell et al., 2007; O'Doherty et al., 2003; Said et al., 2009b; Winston et al., 2002).

In this chapter, we review several lines of research on personality impressions from faces. We discuss research on the accuracy of these impressions (first section: "The accuracy of personality impressions from faces"), the social consequences of these impressions (second section: "Consequences of personality impressions from faces"), the automaticity of forming these impressions (third section: "The automaticity of personality impressions from faces"), recent patient and functional magnetic resonance imaging (fMRI) studies exploring the neural basis of these impressions (fourth section: "Neuroimaging and patient studies of personality impressions from faces"), dimensional approaches to personality impressions from faces (fifth section: "Dimensional approaches to face evaluation"), and potential sources of individual differences in evaluation of faces (sixth section: "The role of individual differences in face evaluation").

The accuracy of personality impressions from faces

It has been known for a long time in psychology that people agree on their personality impressions from faces (Hollingworth, 1922, chapter 3). However, consensus or reliability of judgments is not equivalent to accuracy or validity of these judgments. A detailed review of the accuracy of judgments from facial appearance is beyond the scope of this chapter.[1] Instead, we briefly review selected studies and note the methodological challenges facing research on accuracy.

Early studies on the accuracy of judgments were conducted in the context of personnel selection and tested the relationship between judgments of intelligence from photographs and intelligence measures (Hollingworth, 1922; Laird, 1927). The evidence for the accuracy of judgment was mixed, with some studies failing to find a significant relationship (Laird, 1927, Chapter 6) and some studies finding modest positive correlations between judgments and IQ measures (Pintner, 1918). A meta-analysis of these early studies found an average correlation of .30 (Zebrowitz et al., 2002).

However, many of the earlier studies had methodological flaws (Shepherd, 1989). For example, in the study reporting the highest correlations between individual judgments of intelligence and IQ measures, the variance of IQ was unrepresentative of the general population, ranging from 18 to 171 for 11 individuals (Gaskill et al., 1927).[2] The correlation was almost perfect for individuals with IQ below 100 but negative for individuals with IQ above 100. Interestingly, recent studies have shown that judgments of intelligence correlate with measures of intelligence only for individuals below median attractiveness (Zebrowitz and Rhodes, 2004). This finding was predicted by the "bad genes" hypothesis, which posits that unattractive faces signal poor genetic fitness (e.g. individuals with Down syndrome).

In general, better controlled recent studies have confirmed the relationship between judgments of intelligence and IQ measures, although the correlations were weaker and were only valid for some age groups (e.g. childhood) but not others (e.g. later adulthood). Moreover, attractiveness accounted for these correlations, suggesting that people rely on attractiveness to infer intelligence (Zebrowitz et al., 2002). Because attractiveness happens to be weakly correlated with intelligence, judgments of intelligence predict actual intelligence.

Studies in social and personality psychology have also tested whether trait inferences from faces correlate with self-reports. Several studies have reported moderate correlations for self-reports of approachability, warmth, power and extraversion (Berry, 1991; Berry and Brownlow, 1989; Penton-Voak et al., 2006). However, other studies have failed to find significant correlations for agreeableness, conscientiousness (Pound et al., 2007), and suggestibility (Bachmann and Nurmoja, 2006). Studies have also used behavioral measures with one study finding positive but weak correlations between judgments of honesty and willingness to participate in experiments involving deception of other subjects (Bond et al., 1994) and another failing to find a significant relationship between judgments of honesty and observationally assessed honesty (Zebrowitz et al., 1996).

It is instructive to consider the question of accuracy in the context of studies in which subjects made personality judgments from dynamic video clips of social interaction (Carney et al., 2007), materials much richer than still images of faces. Although subjects were accurate—the accuracy increased for longer clips and clips drawn from the middle and the end of the 5-min interaction—the accuracies of judgments made after 5-s clips from the first minute of the interaction were low, with correlations of −0.12 for positive affect, 0.11 for negative affect, 0.07 for neuroticism, 0.02 for extraversion, 0.21 for openness to experience, −0.03 for agreeableness, 0.12 for conscientiousness, and 0.10 for intelligence.

---

1 Unfortunately, to the best of our knowledge, there are no comprehensive reviews of research on the accuracy of personality impressions from *still images of faces.* There are, however, reviews on the accuracy of person impressions based on various materials, including dynamic videos, voice recordings, and still images. For a recent review, see Hall et al. (2008).

2 For an unbiased estimate of the strength of the true relationship, the variability in the sample of faces should be representative of the variability of faces in the population (Hönekopp et al., 2006).

Recently, there has been a renewed interest in the accuracy of personality impressions with some studies suggesting that sexual orientation (Rule and Ambady, 2008) and aggressiveness (Carré and McCormick, 2008; Carré et al., 2009; Sell et al., 2009) can be inferred from faces at better than chance accuracy. The latter studies are particularly interesting because a plausible biological mechanism can be postulated in light of evidence that testosterone treatment of adolescents leads to increased craniofacial growth (Verdonck et al., 1999) and that fluctuations in testosterone correlate with aggressive behavior (Pound et al., 2008).

Although there is evidence for accuracy in some trait judgments, there is no evidence for accuracy in other judgments. Why, then, do people make these inaccurate judgments, and why are they made so reliably? One of the most intriguing explanations is the *overgeneralization hypothesis* (Zebrowitz, Chapter 3, this volume). Under this hypothesis, certain traits that are accurately revealed by face qualities such as emotion, age, or identity are erroneously perceived in people who merely resemble one of those categories. For instance, there is evidence that neutral faces that resemble the emotion anger are perceived as being low on the affiliation trait, whereas neutral faces that resemble the emotion happiness are perceived as high on affiliation (Montepare and Dobish, 2003; see also Said et al., 2009b). Similarly, babyfaced adults are perceived as having traits consistent with baby stereotypes, such as low social dominance and low intellectual capacity (McArthur and Apatow, 1983; Montepare and Zebrowitz, 1998). The overgeneralization hypothesis is not mutually exclusive with accuracy of impressions, and there is evidence that the two phenomena may interact in interesting ways. Initially inaccurate overgeneralizations can trigger a self-fulfilling prophecy, in which social interactions influenced by face impressions may lead to the actual development of the expected traits (Snyder et al., 1977). Conversely, there is evidence that in some cases, such as with adolescent baby-faced boys, a self-defeating prophecy can be triggered, leading to the behavioral development of the opposite of the perceived face trait (Zebrowitz et al., 1998a). A more complete discussion of these and other issues relating to overgeneralization can be found in Zebrowitz, Chapter 3, this volume.

To summarize, the degree to which trait inferences from faces are accurate will depend on the trait dimension, with some traits showing accuracy (e.g. extraversion) and others not (e.g. agreeableness). Currently, it is not clear what factors determine the degree of accuracy (see Hall et al., 2008). Even if trait judgments predict actual measures of personality, the correlations are fairly low for individual judges. The average correlations between judgments and personality measures are often obtained at the aggregated level of subjects. That is, the personality measures for the target faces are correlated with the mean personality judgments across subjects. As a general statistical rule, this aggregation produces higher correlations than correlations at the level of individual subjects (Dawes, 1970; Hönecopp, 2006). The latter are much weaker and for many subjects negative (e.g. Hollingworth, 1922; Pintner, 1918). For example, in one study, the range of correlations of individual judgments of intelligence and measures of intelligence was from −0.63 to 0.52 with a median correlation of 0.10 (Pintner, 1918). Moreover, facial cues that may have predictive utility are often overweighted in judgments. For example, the magnitude of the correlations between perceived intelligence and attractiveness is two to three times higher than the magnitude of the correlations between actual intelligence and attractiveness (Zebrowitz et al., 2002).

The most important methodological challenge facing research on accuracy concerns the sampling of the stimuli. It would be generally easy to select faces for which people show either good or dismal accuracy (see Laird, 1927, chapter 6, for examples). To establish that judgments are accurate though, one needs to ascertain the representativeness of the stimuli, a condition that would be difficult to satisfy in many situations.

Finally, researchers need to specify the mechanisms through which positive (or negative) correlations between trait inferences from faces and personality characteristics develop. These could range from self-fulfilling (Zebrowitz, 1999) and self-defeating prophecy effects, the latter producing negative correlations (Collins and Zebrowitz, 1995; Zebrowitz et al., 1998a,b), to effects of frequent expressions of specific emotions on facial structure (Malatesta et al., 1987).

Consequences of personality impressions from faces

Whether or not trait inferences from faces are accurate, they affect important social outcomes. The effects of attractiveness on various social outcomes have been extensively documented (Langlois et al., 2000). For example, attractive people have better mating success, job prospects, and earning potential than their less fortunate peers (Dipboye et al.1977; Frieze et al., 1991; Hamermesh and Biddle, 1994; Pashos and Niemitz, 2003; Rhodes et al., 2005). There is also an extensive literature on the effect of baby-faced appearance on social outcomes (Montepare and Zebrowitz, 1998; Zebrowitz, 1999). For example, in small claims court, baby-faced people were less likely to be found at fault than their mature-faced peers when they denied responsibility for intentional but not negligent actions (Zebrowitz and McDonald, 1991).

These findings clearly suggest that people act on their impressions from facial appearance (Hassin and Trope, 2000). The effects of appearance on social outcomes may be partly attributable to halo effects (Nisbett and Wilson, 1977), global evaluations that can influence the perception of specific traits. For example, attractiveness correlates with perceptions of intelligence, friendliness, and a host of other social evaluations (Eagly et al., 1991). Similarly, babyfaced appearance correlates with perceptions of honesty, intelligence, assertiveness, approachability, and many other evaluations (Montepare and Zebrowitz, 1998). Thus, variations on these basic dimensions can give rise to specific trait inferences relevant to the specific context. For example, attractive people may be perceived as more competent and, hence, paid a "premium" for their performance (Hamermesh and Biddle, 1994). Facially mature looking people may be perceived as more dominant (Keating and Bai, 1986; Keating et al., 1981), and these perceptions can influence their professional outcomes such as military rank attainment (Mazur and Mueller, 1996; Mazur et al., 1984; Mueller and Mazur, 1996). Similar halo effects may operate for social categories too. For example, several studies have found that race stereotypical face features predicted sentencing decisions (Blair et al., 2004; Eberhardt et al., 2006), presumably by activating general stereotypes that affected specific decisions.

However, variations on general dimensions such as attractiveness and facial maturity may not be sufficient to account for all effects of impressions from faces on social outcomes. For example, there have been a number of recent studies showing that inferences related to competence and leadership predict electoral success (Antonakis and Delgas, 2009; Ballew and Todorov, 2007; Little et al., 2007), even when variations on general dimensions are controlled (Hall et al., 2009; Poutvaara et al., 2009; Todorov et al., 2005; for a review see Olivola and Todorov, 2010). One of the surprising findings of this research was the specificity of the effects. People generally report that competence is the most important attribute for a politician and inferences of this attribute, but not inferences of attributes considered unimportant, predict electoral success (Hall et al., 2009). Moreover, inferences of competence remain a significant predictor of electoral success even when the analysis controls for age, babyfaced appearance, attractiveness, face familiarity, and a dozen personality impressions from the faces of political candidates (Olivola and Todorov, 2010).

How personality impressions from faces affect social outcomes appears to depend on the specific context of choices. The research findings suggest that the decision context determines the primary dimensions of importance and that inferences along these dimensions affect decisions (Brownlow, 1992; Brownlow and Zebrowitz, 1990; DeBruine, 2002; Little et al., 2007). For example, in the context of a war voters prefer masculine and dominant looking leaders.

Conversely, in the context of peace they prefer feminine and intelligent looking leaders (Little et al., 2007). Thus, researchers interested in predicting how impressions from faces affect decisions need to first determine the relevant personality dimensions for the context and then measure impressions on these dimensions.

The automaticity of personality impressions from faces

Facial attractiveness is one of the most thoroughly studied face properties (Rhodes 2006; Langlois et al., 2000; Penton-Voak and Morrison, Chapter 33, this volume) and the initial studies on the efficiency of impressions from faces focused on judgments of attractiveness (Locher et al., 1993; Olson and Marshuetz, 2005). Locher et al. (1993) showed that 100 ms exposure to faces was sufficient for subjects to discriminate between different levels of facial attractiveness. Olson and Marshuetz (2005) replicated these findings using extremely short subliminal exposures to faces (13 ms) suggesting that attractiveness is extracted automatically from facial appearance.

The findings that attractiveness can be perceived after brief exposures to faces have been extended to personality inferences (Ballew and Todorov, 2007; Bar et al., 2006; Todorov et al., 2009; Willis and Todorov, 2006). In addition to attractiveness, Willis and Todorov (2006) studied four other judgments: likeability, trustworthiness, competence, and aggressiveness. For all five judgments, judgments made after 100 ms exposure to faces were highly correlated with judgments made in the absence of time constraints. Additional time exposure did not improve these correlations. However, with increased exposure, judgments on different traits become less correlated with each other, suggesting that additional time allowed the subjects to form more differentiated impressions.

Bar et al. (2006) studied judgments of threat and intelligence. They showed that judgments of threat made after 39 ms exposure correlated highly with judgments made after 1700 ms. In contrast, judgments of intelligence made after brief exposures were much less consistent with judgments made after longer exposures. These findings suggest that survival-related traits with respect to immediate threat may have an advantage in visual processing over other traits.

Todorov et al. (2009, Exp. 2) studied judgments of trustworthiness after time exposures ranging from 17 ms to unlimited time. Similar to the findings of Bar et al. (2006), who did not observe consistency in judgments after extremely brief, subliminal exposures to faces (26 ms), Todorov et al. did not observe significant correlations between judgments made after 17 ms exposure and judgments made in the absence of time constraints. However, the correlation was significant for 33 ms exposure and increased as a sigmoid function of time exposure. The correlation increased dramatically with the increase in exposure from 33 to 100 ms and reached a plateau after 167 ms exposure.

At first blush, the findings of Bar et al. (2006) and Todorov et al. (2009) suggest that trait judgments from faces are not made after subliminal exposure, in contrast to judgments of attractiveness (Olson and Marshuetz, 2005). However, two possible reasons for the failure to obtain significant effects for trait judgments after subliminal exposure are that explicit judgment tasks may not be sensitive enough to detect such effects and that the face stimuli used in the studies were not extreme enough. In fact, in the study by Olson and Marshuetz (2005), the mean difference between attractive and unattractive faces was 5 points on a 10-point scale and the distributions were completely non-overlapping.

Todorov et al. (2009, Exp. 3) used faces generated by a computer model of face trustworthiness (Oosterhof and Todorov, 2008) in a subliminal priming paradigm. Extremely trustworthy or untrustworthy versions of faces were presented for 20 ms and immediately masked by the neutral version of the face, which was presented for 50 ms The subject's task was to judge the latter face.

Todorov et al. found that neutral faces were perceived as more trustworthy when they were preceded by trustworthy primes than when preceded by untrustworthy primes. This was the case even though an objective test of awareness failed to find any evidence for the awareness of the primes.

The findings reviewed in this section show that people can make a variety of trait inferences after extremely brief exposures to emotionally neutral faces, suggesting that such inferences are made automatically. There are several outstanding questions in this research. First, it is possible that the minimum time exposure of visual information necessary to make a trait judgment depends on the specific trait dimension. As argued by Bar et al. (2006), survival related trait inferences might have a visual advantage over other inferences. A second and related question is to what extent person inferences made after minimal exposure to faces are about specific traits (e.g. trustworthiness) or global dimensions (e.g. valence) (Todorov et al., 2009; Willis and Todorov 2006). As we outline in the section "Dimensional approaches to face evaluation" (see also Oosterhof and Todorov, 2008; Todorov et al., 2008a), trait inferences from faces are highly correlated with each other and it is possible that after extremely brief exposures, people make global valence related inferences rather than specific trait inferences. The specificity of inferences may also depend on the decision context and the relevance of the trait to this context (see section "Consequences of personality impressions from faces"). Finally, we know little about how social judgments are computed within a single glance of a face. Such rapid processing can rely on holistic information (Bar et al., 2006; Abbas and Duchaine, 2008; Santos and Young, 2008; Todorov et al., 2010) feature information (Cloutier et al., 2005; Cloutier and Macrae, 2007; Martin and Macrae, 2007; Schyns et al., 2008), or a combination of both (see also Rossion and Michel, Chapter 12; Tanaka and Gordon, Chapter 10, this volume).

Neuroimaging and patient studies of personality impressions from faces

Most of the cognitive neuroscience research on social judgments from faces has been on perceptions of attractiveness and trustworthiness (Adolphs et al., 1998; Aharon et al., 2001; O'Doherty et al., 2003; Todorov and Engell, 2008). Several fMRI studies have attempted to identify brain regions that show variable responses to different levels of facial attractiveness. A hypothesis in most of these studies is that perceptions of attractiveness should be related to activation in reward-related brain regions. Consistent with this hypothesis, the medial orbitofrontal cortex (mOFC) activated reliably across these studies, with greater activation as attractiveness increased (Cloutier et al., 2008; Kranz and Ishai, 2006; O'Doherty et al., 2003; Winston et al., 2007). Conversely, the lateral orbitofrontal cortex (lOFC) showed greater activation with decreasing levels of attractiveness (Cloutier et al., 2008; O'Doherty et al., 2003). This dissociation has been interpreted in light of evidence that mOFC activates in response to abstract monetary reward while the lOFC activates to abstract monetary punishment (O'Doherty et al., 2001). According to this interpretation, mOFC activates to attractive faces because they are rewarding, and lOFC activates to unattractive faces because they are not rewarding. However, the distinction between lOFC and mOFC is not a strict dissociation. There is evidence that rewarding gustatory stimuli can activate the lOFC (O'Doherty et al., 2002) and a fairly lateral OFC response to attractive faces has been found in one study (Aharon et al., 2001).

The nucleus accumbens (NAcc) has also been reported to respond more strongly to attractive faces in several studies (Aharon et al., 2001; Cloutier et al., 2008) and, like the mOFC, it has been interpreted with reference to its known role in reward processing (Breiter et al., 1997; Schultz 2000). However, many attractiveness studies have not reported NAcc activation (Kampe et al., 2001; Kranz and Ishai, 2006; O'Doherty et al., 2003; Winston et al., 2007). The reason for this discrepancy is not entirely clear, but one possibility is that the studies that found it only showed faces of the opposite gender of the subject, whereas the studies that did not find it showed both genders to each subject. As proposed by Cloutier et al. (2008), it may be possible that opposite gender-only paradigms put subjects in more of a mate-seeking context in which attractive faces of opposite gender are particularly rewarding.

The anterior cingulate cortex (ACC) shows greater activation to attractive faces than to unattractive faces, according to two studies (Winston et al., 2007; Cloutier et al., 2008). Because the ACC is known to generate and monitor autonomic states (Critchley, 2004; Teves et al., 2004), it is possible that its activity during the presentation of attractive faces reflects autonomic arousal. Support for this hypothesis comes from a study (Winston et al., 2007), in which only males showed increased pupil dilation—an indicator of autonomic arousal—and increased ACC activation to attractive faces.

Most studies on perceptions of face trustworthiness have focused on the amygdala, following a study by Adolphs et al. (1998). Adolphs and his colleagues tested three bilateral amygdala damage patients, other brain damage controls, and normal controls on perceptions of approachability and trustworthiness. Relative to the controls, bilateral amygdala damage patients showed a specific bias to give high ratings of trustworthiness and approachability to faces that were judged by normal controls as untrustworthy and unapproachable. In addition, participants who are given an intranasal dose of oxytocin, which is believed to work in part by dampening amygdala activity (Kirsch et al., 2005), make higher judgments of trustworthiness than controls (Theodoridou et al., 2009). Interestingly, in contrast to bilateral amygdala damage patients, some developmental prosopagnosics (Duchaine, Chapter 42, this volume) are able to make normal trustworthiness judgments (Todorov and Duchaine, 2008). These findings suggest that the neural systems that underlie face evaluation and processing of facial identity are at least partially dissociable.

Several fMRI studies with normal participants have confirmed the amygdala's involvement in perceptions of trustworthiness (Engell et al., 2007; Winston et al., 2002). Winston and his colleagues (2002) showed that the amygdala's response decreased with the trustworthiness of faces, as assessed by the subjects' judgments of the faces after the brain imaging session. Importantly, this was the case independent of the subjects' task in the scanner: judging trustworthiness or age of faces. Engell and his colleagues (2007) replicated the findings that the activation in the amygdala decreased with face trustworthiness, using only an implicit task to rule out the possibility that performance on implicit trials was influenced by prior performance on explicit trials. They also showed that the amygdala's response to face trustworthiness was driven by structural properties of the face that signal trustworthiness across perceivers rather than by idiosyncratic components of trustworthiness judgments (see section "The role of individual differences in face evaluation"). Todorov et al. (2008a) replicated these findings, using faces generated by a computer model of face trustworthiness.

Although all initial fMRI studies reported a linear amygdala response to face trustworthiness, two subsequent studies found a non-linear response (Said et al., 2009a; Todorov et al., 2008b). Using an explicit evaluation task, Said and colleagues showed that the response to extremely trustworthy and untrustworthy faces was larger than the response to faces in the middle of the continuum, although the response was more sensitive to differences at the negative end of the continuum. Using an implicit evaluation task, Todorov and colleagues (2008b) found a similar quadratic response in the left but not the right amygdala.

A similar non-linear response in the amygdala has also been observed for attractiveness (Winston et al., 2007). Most studies on attractiveness have either compared the effect of attractive faces to unattractive faces, or have looked at linear effects of attractiveness along a continuum. As noted in Winston et al. (2007), this may be the reason that so few studies have identified an amygdala response to attractiveness. Drawing from evidence that the amygdala responds both to positive and negative stimuli (Baxter and Murray, 2002), Winston et al. (2007) found quadratic effects of attractiveness in the amygdala, such that it responded strongly to very attractive and very unattractive faces, but weakly to faces in the middle of the continuum. Cunningham and his colleagues (Cunningham et al., 2008) have also observed a non-linear amygdala response to the valence of person names. Moreover, they found that the response was sensitive to the current goals of the subject. For instance, if the subject's task was to attend to the positivity rather than the negativity of the names, the response to positivity was enhanced.

What are we to make of all the consistencies and inconsistencies in the neuroimaging literature on attractiveness and trustworthiness? Although it is true that some regions such as the mOFC and NAcc activate in multiple studies on attractiveness, many other studies do not report them, and in any case the interpretation in studies that do find them is not always clear. Similar issues of interpretation confront research on face trustworthiness. Although the amygdala has been implicated in multiple studies, it is not clear under what conditions the amygdala's response is linear or non-linear, and there is surprisingly little overlap in activated regions other than the amygdala across studies.

Two main conclusions can be drawn from the literature. First, because of the diversity of results, looking for an "attractiveness network" or "trustworthiness network" may not be the best approach. As we argue below (section "Dimensional approaches to face evaluation"), some of the observed findings may be reinterpreted as responding to face valence or other general face qualities rather than to specific trait attributes. Further, there doesn't seem to be a set of brain regions that consistently varies with attractiveness or trustworthiness, at least at statistically significant levels; rather, the brain is engaged in diverse ways that heavily reflect task and motivational context. The challenge for future research would be to specify how context variables affect neural processes of face evaluation. Second, to the extent that some brain regions are more involved than others, neuroimaging does not tell us whether activation in these regions is necessary for social judgments, or merely a downstream consequence of judgments computed in other regions. As has been often noted, case studies of patients with localized brain damage can provide the causal information (Shallice, 1988) that neuroimaging cannot provide (Poldrack, 2006; Sarter et al., 1996).

Dimensional approaches to face evaluation

As mentioned above, trait judgments from faces are highly correlated with each other. For example, it is almost impossible to find social judgments that are uncorrelated with judgments of trustworthiness. Moreover, these correlations are sizeable (e.g. 0.83 with judgments of emotional stability, 0.75 with judgments of attractiveness, −0.76 with judgments of aggressiveness, 0.63 with judgments of intelligence, etc.; see Oosterhof and Todorov 2008). These high correlations suggest that there is a simple dimensional structure that accounts for most of the variance in social judgments. Using principal components analysis (PCA) on judgments of both natural and computer generated faces, Oosterhof and Todorov (2008) have shown that the first two components, best interpreted as valence/trustworthiness and power/dominance, account for most of the variance in judgments. This solution corresponds to other dimensional models of social perception (Fiske et al., 2007; Vigil, 2009; Wiggins, 1979; Wiggins et al., 1989). Trustworthiness judgments were closest to the first component and dominance judgments to the second component. For example, the correlations of trustworthiness judgments with the first and second components, derived from a PCA of 11 other trait judgments excluding trustworthiness and dominance, were 0.92 and −0.10, respectively. In contrast, dominance judgments were highly correlated with the second (0.87) but not with the first component (−0.20). The finding that trustworthiness judgments may serve as a proxy of general valence evaluation suggests that the amygdala may be involved not in assessments of face trustworthiness per se but in assessments of general valence in the service of approach/avoidance responses by the perceiver (Todorov, 2008).

This hypothesis was tested and confirmed by Todorov and Engell (2008). They reanalyzed the fMRI data from Engell et al. (2007) as a function of a large set of trait judgments. In the original study, the subject's ostensible task was to memorize faces and, hence, the instructions did not bias subjects to attend to a specific trait dimension. Todorov and Engell first selected face responsive voxels and then computed the average response in the face responsive regions to each face. Then they analyzed the correlations between the response to faces in face-selective regions and trait judgments of these faces. As shown in Figure 32.1, almost all trait judgments correlated with the

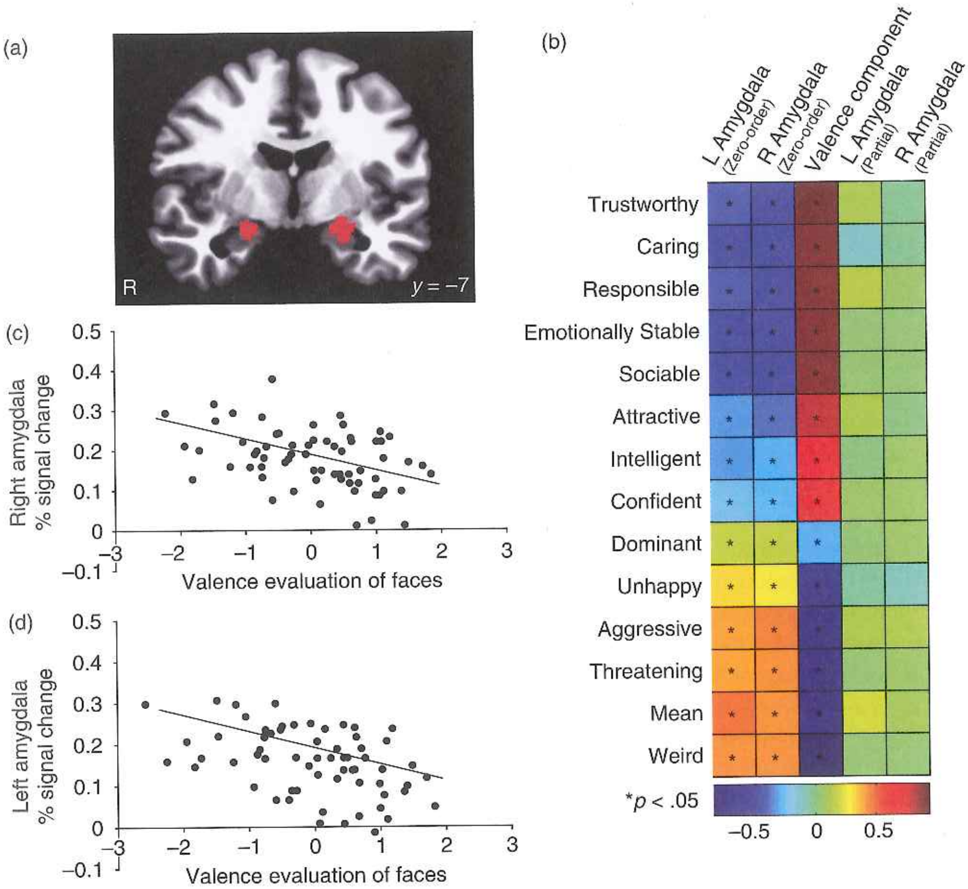

Fig. 32.1 The relation between the amygdala's response to emotionally neutral faces and variations of these faces on trait dimensions. (a) A coronal brain slice showing face responsive voxels in bilateral amygdala. (b) An intensity color plot showing correlations between the response in left and right amygdalae to faces and trait judgments of these faces. The first two columns show zero-order correlations and the fourth and fifth columns show partial correlations controlling for the valence content of the judgments. The third column shows the correlations between trait judgments and a valence component derived from a principal components analysis of the judgments. The traits are ordered according to their correlations with the valence component. Scatter plots of the amygdala's response to faces (c for right and d for left) and their values on the valence component. Each point represents a face. Reproduced from Todorov and Engell, The role of the amygdala in implicit evaluation of emotionally neutral faces, 2008, *Social Cognitive and Affective Neuroscience*, with permission from Oxford University Press.

amygdala response to faces. Positive traits correlated with decreases in the response and negative traits correlated with increases in the response. Moreover, the magnitude of the correlation varied systematically as a function of the valence content of the judgments, as assessed by the shared variance of the judgments with the first component of a PCA of the judgments. The more evaluative the judgment, the more strongly the amygdala was engaged. After controlling for the valence content of the judgments, the correlations between the amygdala response and trait judgments were no longer significant. The same pattern of responses was observed in a number of regions in occipital and inferior temporal cortices, although the magnitude of the correlations was smaller.

Given that judgments of trustworthiness and dominance are good approximations of the general dimensions of face evaluation, Oosterhof and Todorov (2008) built computer models representing how faces change along these dimensions (Figure 32.2). Specifically, they used a data-driven model in which faces are represented as points in a multidimensional space (Blanz and Vetter, 1999 and 2003; O'Toole, Chapter 2, this volume; Singular Inversions 2006; Vetter and Walker, Chapter 20, this volume). This model can generate an unlimited number of faces that are each linear combinations of the model dimensions. Judgments of randomly generated faces can be used to construct a novel dimension that is optimal in representing face variations along a particular social dimension.

Using this approach, Oosterhof and Todorov (2008; see also Todorov et al., 2008b) created dimensions that varied optimally in perceived trustworthiness and dominance. By investigating the range of faces along these dimensions, they showed that these judgments are based on similarity to facial cues that have adaptive significance. As shown in Figure 32.2d, exaggerating faces along the trustworthiness dimension resulted in angry faces on the negative end and in happy faces on the positive end of the dimension. (For convergent evidence from dynamic stimuli, see Oosterhof and Todorov, 2009). This finding suggests that valence evaluation of faces is based on cues initiating approach/avoidance behavior by the perceiver (Fridlund, 1994). Exaggerating faces along the dominance dimension resulted in extremely masculine, mature faces on the dominant end and in extremely feminine, baby-faced faces on the submissive end of the dimension. This finding is consistent with a rich body of evidence about the importance of neotenous and sexually dimorphic features in face perception (Perrett et al., 1998; McArthur and Apatow, 1983; Rhodes 2006; also Penton-Voak and Morrison, Chapter 33; Zebrowitz, Chapter 3, this volume). In general, the findings suggest that inferences along the valence/trustworthiness dimension are about the intentions of the person with respect to potential harm and inferences along the power/dominance dimension are about the capacity of the person to implement these intensions (cf. Fiske et al., 2007).

Dimensional approaches provide a parsimonious, powerful framework for the study of face evaluation. However, they may not be sufficient to account for judgments in specific contexts (Todorov, 2009). That is, while these models focus on identifying the commonalities among various judgments, interesting behavioral effects may be due to variance that is specific to a judgment, and not shared with general components. Further, the strong claim of dimensional models is that specific judgments can be represented within the dimensional framework. In fact, Oosterhof and Todorov (2008) showed that judgments of threat could be represented as a linear combination of untrustworthiness and dominance. However, their model was not particularly good at representing judgments of attractiveness, extraversion, and competence within the two-dimensional framework.

Finally, it is important to provide convergent evidence from other computer models (see Said et al., 2009a). For example, the computer model used by Oosterhof and Todorov (2008) is based on shape information and is not good at representing texture, an important determinant of face perception. Other techniques such as PCA methods (Brahnam, 2005) and reverse correlation

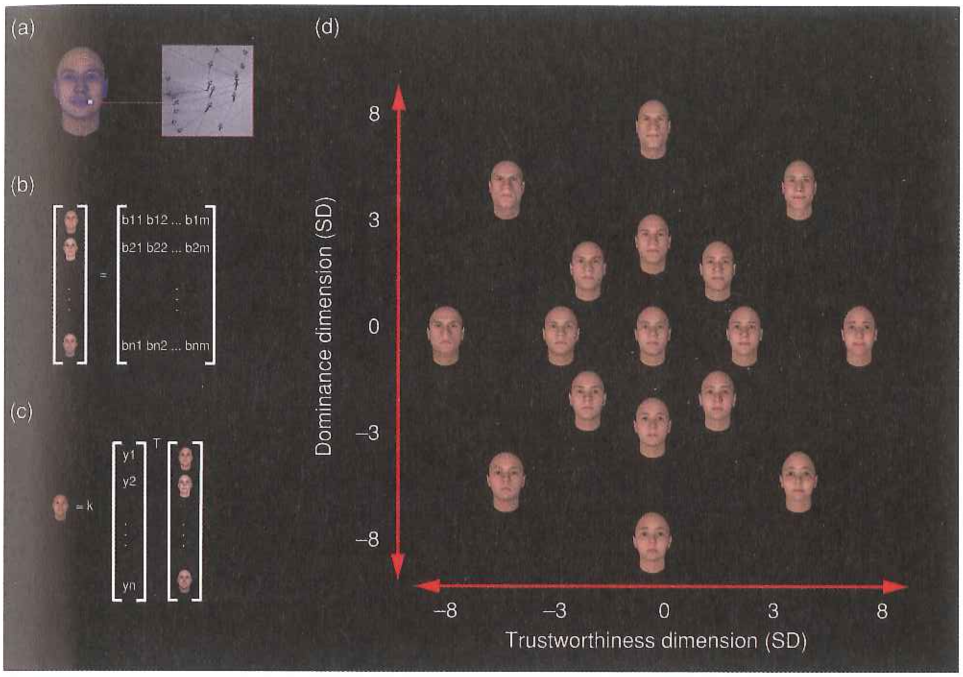

Fig. 32.2 Computer modeling of social judgments of faces. (a) Illustration of how the face model represents faces. Left: a surface mesh with fixed topology superimposed on the average face. Right: an expanded view of a section of the mesh, along with direction vectors specifying the linear changes in the vertex positions for the surface for one of the m = 50 shape dimensions. (b) A set of n random faces can be obtained by linear combinations of the m shape components, and represented in an n by m matrix. These dimensions are extracted from a principal component analysis of shape variations of the vertex positions and do not necessarily have inherent psychological meaning. Each row of the matrix contains the set of m weighting coefficients corresponding to a particular face. (c) Each of the n faces is rated by participants on a trait dimension and given an average score yj. Multiplication of the social judgments vector by the set of randomly generated faces yields a dimension that is optimal in changing faces on the trait dimension, which can be controlled with a tunable constant k. The figure shows the generation of one face along the trustworthiness dimension. (d) A two-dimensional model of evaluation of faces. Examples of a face with exaggerated features on the two orthogonal dimensions—trustworthiness plotted on the x-axis and dominance plotted on the y-axis—of face evaluation. The changes in features were implemented in a computer model based on trustworthiness and dominance judgments of n = 300 emotionally neutral faces (Oosterhof and Todorov, 2008). The extent of face exaggeration is presented in SD units. The faces on the diagonals were obtained by averaging the faces on the trustworthiness and dominance dimensions. The diagonal dimension passing from the 2nd to the 4th quadrant was nearly identical to a dimension based on threat judgments of faces. The other diagonal dimension passing from the 1st to the 3rd quadrant was similar to dimensions empirically obtained from judgments of likeability, extraversion, and competence. Reprinted from *Trends in Cognitive Sciences*, Todorov, Said, Engell, and Oosterhof, Understanding evaluation of faces on social dimensions, © 2008 with permission from Elsevier.

methods (Gosselin and Schyns, 2001; Mangini and Biederman, 2004), in which subjects make decisions on noisy images, may be particularly useful for discovering the cues used for face evaluation in a data-driven way. Reverse correlation methods have already been used to discover the cues used for judgments of expressions of emotions, gender, and identity (Schyns et al., 2002; Smith et al., 2005). They can also be used to study social judgments. For example, Dotsch et al. (2008) have used these methods to reveal the prototypical face representations of stigmatized out-groups.

The role of individual differences in face evaluation

As described in the first section, there is a surprising amount of consensus in judgments from faces, although this consensus varies as a function of the judged trait (Oosterhof and Todorov, 2008). The common statistic typically used to report consensus in judgments is Cronbach's alpha—a measure of the consistency of raters. However, as noted by Hönekopp (2006), this statistic describes reliability across samples of judges[3] and it is not clear how to interpret it at the level of individual raters. In fact, given a large sample of raters, Cronbach's alpha can be very high even when the inter-rater agreement is very low. Typically, the inter-rater agreement is not very high. For example, this agreement ranged from 0.09 to 0.47 (correlation coefficients) across 15 different trait judgments (Oosterhof and Todorov, 2008).[4] That is, the average shared variance between pairs of raters ranged from 0.8% to 22.1%. Thus, despite consensus in trait judgments, a large proportion of variance in these judgments is unaccounted for. Recent empirical work suggests that some of this variance may be attributable to individual differences (Engell et al., 2007; Hönekopp 2006). For example, Hönekopp (2006) estimated that half of the meaningful variance in attractiveness judgments is due to consensus contributions and half to idiosyncratic contributions.

We know very little about the sources of idiosyncratic variation in face evaluation. Whereas computer models of social judgments (Brahnam, 2005; Oosterhof and Todorov, 2008), which rely on averaging of judgments across judges, may be particularly appropriate for discovering consensual cues and their possible evolutionary and cultural origin, they may not be the best approach to capture cues to individual variations in judgments. Because the latter cues would differ across individuals, they would not be revealed in an average judgment. A key area for future research is the investigation of the determinants of individual variation in social judgments from faces. Likely candidates for these determinants are self-resemblance, similarity to faces of people with known personality dispositions, and individual differences in perceiver personality.[5]

Several studies have shown that faces that have been subtly manipulated to resemble the self (by morphing faces with the self face) are evaluated and treated more positively than control faces

[3] One way to understand this statistic is in terms of the agreement between the face ratings of two different groups of subjects. For example, an alpha of 0.90 indicates that this is the expected correlation between the mean observed face ratings (averaged across subjects) and the mean ratings of a new group of subjects with the same sample size.

[4] It should be noted that the subjects in Oosterhof and Todorov (2008) rated the faces three times and the agreement was computed from their mean ratings for each face. This procedure typically increases inter-rater agreement and, correspondingly, reliability. The inter-rater agreement from the first face ratings of the subjects was more modest, ranging from 0.04 to 0.35 across the 15 traits.

[5] For an interesting treatment of individual differences in face evaluation from the perspective of a Gibsonian approach in terms of social affordances and perceivers' attunements, see Zebrowitz (Chapter 3, this volume).

(Bailenson et al., 2006, 2008; DeBruine, 2002, 2005; Krupp et al., 2008). For example, subjects perceive self-resembling faces as more trustworthy (DeBruine, 2005), show more trusting behaviors in economic games with self-resembling partners (DeBruine, 2002; Krupp et al., 2008), and are more likely to vote for political candidates who resemble them (Bailenson et al., 2006, 2008).

The second source of idiosyncratic face evaluation may derive from learning about other people. While impressions of unfamiliar people are certainly influenced by their facial appearance (see sections "Consequences of personality impressions from faces" and "The automaticity of personality impressions from faces"), this does not mean these impressions are not changeable in light of new information (Todorov and Olson, 2008). In fact, such impressions can be rapidly changed based on minimal information (Bliss-Moreau et al., 2008; Johnson et al., 1985; Todorov et al., 2007; Todorov and Uleman, 2002, 2003, 2004). These processes are probably adaptive: people should be able to rapidly learn about other people and overwrite initial impressions. In addition, there is evidence that personality information can affect the evaluation of physical appearance (Gross and Croften, 1977; Hassin and Trope, 2000; Kniffin and Wilson, 2004; Paunonen, 2006). For instance, learning that someone is kindhearted or mean influences judgments of physical attractiveness (Hassin and Trope, 2000).

Given the importance of learning and consistent with the familiar face overgeneralization hypothesis (Zebrowitz, Chapter 3, this volume; Zebrowitz and Collins, 1997), an interesting possibility is that knowledge of familiar others can generalize to novel faces that resemble the faces of these others. Consistent with this possibility, Andersen and colleagues have demonstrated that participants' impressions of familiar others are affected by the similarity of those others to participants' own significant others (Andersen and Baum, 1994; Andersen and Cole, 1990). However, they have not yet investigated the role of physical similarity in this process. Indeed, there are very few experimental studies showing that experience with one set of faces leads to changes in judgments of another set of faces (Hill et al., 1990; Lewicki, 1985; Jones et al., 2007). In one such study, Hill et al. (1990) created an association between the length of faces and their fairness and then showed that this association influenced judgments of novel faces. In a more recent study, Jones et al. (2007) showed subjects composite faces whose constituent faces had been previously associated with either neutral or aversive sounds. They found that subjects preferred composites of faces previously paired with neutral sounds over composites of faces previously paired with aversive sounds. Together, these studies suggest that experience with familiar others may influence judgments about novel faces that resemble these familiar others.

Finally, perceiver goals, insofar as they persist through time, may also contribute to idiosyncratic variance in the evaluation of faces. For instance, the desire for certain personality characteristics (e.g. assertiveness) in a partner has been found to influence judgments of facial attractiveness. Specifically, Little et al. (2006) found that composites made from faces that were judged as attractive by individuals who value certain personality traits are seen as expressing those traits to a greater extent than composites from people who do not value those traits. Although trait judgments tend to be highly correlated with each other (see section "Dimensional approaches to face evaluation"), this study suggests that the relationship between specific judgments and overall evaluation may differ in a meaningful way across perceivers (see also Little and Perrett, 2002).

Traditionally, the focus of face evaluation research has been on the cues in the face that "signal" specific evaluations across perceivers. However, there is a large individual variation in these evaluations and, as we argued, this variation can originate in specific individual experiences with faces and self-resemblance. Future research needs to use statistical models (e.g. Hönekopp, 2006) to partition the variance in judgments of faces to variance due to consensus or properties of the face and variance due to the judge or idiosyncratic variance and then experimentally test what variables differentially affect these two sources of variance.

Summary and conclusions

People routinely make personality inferences from facial appearance, even though these inferences are not necessarily accurate. In the first section, we reviewed evidence for the accuracy of these inferences. Although there have been studies finding positive relationships between judgments from faces and measures of personality (Berry, 1991; Berry and Brownlow, 1989; Penton-Voak et al., 2006), there have been other studies failing to find such relationships (Bachmann and Nurmoja, 2006; Pound et al., 2007; Zebrowitz et al., 1996) and some finding negative relationships (Collins and Zebrowitz, 1995; Zebrowitz et al., 1998a,b). The most important methodological challenge for studies on accuracy is ascertaining the representativeness of face stimuli. This representativeness is a precondition for estimating the true relationship between personality inferences from faces and measures of personality. The most important conceptual challenge for studies on accuracy is positing plausible biological and social interaction mechanisms that can lead to positive or negative relationships between face inferences and measures of personality.

Although personality impressions from faces are not necessarily accurate, they affect important social outcomes ranging from sentencing decisions to electoral success (Blair et al., 2004; Eberhardt et al., 2006; Olivola and Todorov, 2010). In the second section ("Consequences of personality impressions from faces"), we reviewed evidence for the impact of these impressions. Interestingly, the degree to which personality inferences predict social outcomes depends on whether these inferences match the specific context of decision. For example, voters believe that competence is the most important attribute for a politician and inferences of competence from facial appearance, but not likeability, predict electoral success (Olivola and Todorov, 2010; Todorov et al., 2005). An important question for future research is how face inferences are integrated with other person information in decisions.

In the third section ("The automaticity of personality impressions from faces"), we reviewed studies showing that personality inferences are formed after extremely brief exposures to faces, suggesting that these inferences are automatic. For example, such inferences can be formed after as little as 40 ms exposure to faces (Bar et al., 2006; Todorov et al., 2009). Important questions for future research include whether some inferences have advantage in visual processing over other inferences and whether inferences made after rapid exposure are global, evaluative inferences linked to approach/avoidance responses rather than specific trait inferences.

In the fourth section ("Neuroimaging and patient studies of personality impressions from faces"), we reviewed cognitive neuroscience studies probing the neural basis of personality impressions from faces. Evidence from these studies suggests that such inferences engage brain regions implicated in reward-related and affective processing. However, although some regions—medial OFC in studies on attractiveness and amygdala in studies on trustworthiness—are consistently activated in fMRI studies, there is little overlap in other activated regions. The main challenge for future studies is to specify how context variables—task and motivational context—affect the processes of face evaluation and whether different processes engage different functional brain networks.

Although people make multiple trait inferences from faces, these inferences are highly intercorrelated. In the fifth section ("Dimensional approaches to face evaluation"), we reviewed recent dimensional approaches that posit that specific trait inferences can be represented within a two-dimensional space defined by valence/trustworthiness and power/dominance evaluation (Todorov et al., 2008b). Further, we reviewed evidence from data-driven methods that inferences along these dimensions are based on similarity to expressions signaling approach/avoidance behaviors and features signaling physical strength, respectively. Convergent evidence from other data-driven methods is needed to confirm these hypotheses. Finally, although dimensional models provide a parsimonious framework for the study of face evaluation, they may not be sufficient to account for face evaluation in specific contexts (see the second section).

The approaches reviewed in the fifth section are particularly useful for modeling consensus contributions to face evaluation or the facial properties that are uniformly perceived across perceivers to signal a specific quality. In the final section ("The role of individual differences in face evaluation"), we reviewed an ignored aspect of face evaluation: the idiosyncratic contributions of the perceivers to face evaluation. Findings that self-resemblance, learning, and personality differences affect the evaluation of faces suggest that these may be some of the determinants of idiosyncratic evaluation of faces. The challenge for future studies is to experimentally demonstrate these links.

The human face is a source of perennial fascination as a window to personality. Many people still believe that faces provide accurate information about personality and that important decisions can be based on this information (Hassin and Trope, 2000), although individual judgments are weakly correlated at best with personality measures. These impressions are formed rapidly, are consistent across observers, and are predictive of important social outcomes. The consistency in impressions is based on cues with adaptive significance such as similarity to emotional expressions (Montepare and Dobish 2003; Said et al., 2009b), neotenous features (Zebrowitz et al., 2003) and kin resemblance (DeBruine 2002, 2005).

Acknowledgments

We thank Jenny Porter for her help with the preparation of the chapter and Gill Rhodes for her insightful comments. Work on this chapter was supported by National Science Foundation grant NSF 0823749 and SAGE Young Scholar Award to AT.

References

Abbas, Z-A. and Duchaine, B. (2008). The role of holistic processing in judgments of facial attractiveness. *Perception*, **37**, 1187–1196.

Adolphs, R. (2003). Cognitive neuroscience of human social behavior. *Nature Reviews Neuroscience*, **4**, 165–178.

Adolphs, R., Tranel, D., and Damasio, A.R. (1998). The human amygdala in social judgment. *Nature*, **393**, 470–474.

Aharon, I., Etcoff, N., Ariely, D., Chabris, C.F., O'Connor, E., and Breiter, H.C. (2001). Beautiful faces have variable reward value: fMRI and behavioral evidence. *Neuron*, **32**, 537–551.

Andersen, S.M. and Baum, A. (1994). Transference in interpersonal relations: Inferences and affect based on significant-other representations. *Journal of Personality*, **62**, 459–497.

Andersen, S.M. and Cole, S.W. (1990). Do I know you?: The role of significant others in general social perception. *Journal of Personality and Social Psychology*, **59**, 384–399.

Antonakis, J. and Dalgas, O. (2009). Predicting elections: Child's play! *Science*, **323**, 1183.

Bachmann, T. and Nurmoja, M. (2006). Are there affordances of suggestibility in facial appearance? *Journal of Nonverbal Behavior*, **30**, 87–92.

Bailenson, J.N., Garland, P., Iyengar, S., and Yee N. (2006). Transformed facial similarity as a political cue: A preliminary investigation. *Political Psychology*, **27**, 373–385.

Bailenson, J.N., Iyengar, S., Yee, N., and Collins, N.A. (2008). Facial similarity between voters and candidates causes influence. *Public Opinion Quarterly*, **72**, 935–961.

Ballew, C.C. and Todorov, A. (2007). Predicting political elections from rapid and unreflective face judgments. *Proceedings of the National Academy of Sciences of the USA*, **104**, 17948–17953.

Bar, M., Neta, M., and Linz, H. (2006). Very first impressions. *Emotion*, **6**, 269–278.

Baxter, M.G. and Murray, E.A. (2002). The amygdala and reward. *Nature Reviews Neuroscience*, **3**, 563–573.

Berry, D.S. (1991). Accuracy in social-perception—contributions of facial and vocal Information. *Journal of Personality and Social Psychology*, **61**, 298–307.

Berry, D.S. and Brownlow, S. (1989). Were the physiognomists right— personality-correlates of facial babyishness. *Personlaity and Social Psycholology Bulletin*, **15**, 266–279.

Blair, I.V., Judd, C.M., and Chapleau, K.M. (2004). The influence of Afrocentric facial features in criminal sentencing. *Psychological Science*, **15**, 674–679.

Blanz, V. and Vetter, T. (1999). A morphable model for the synthesis of 3D faces. In *Proceedings of the 26th annual conference on Computer graphics and interactive techniques*, 187–194.

Blanz, V. and Vetter, T. (2003). Face recognition based on fitting a 3D morphable model. *IEEE Transactions on pattern analysis and machine intelligence*, **25**, 1063–1074.

Bliss-Moreau, E., Barrett, L.F., and Wright, C.I. (2008). Individual differences in learning the affective value of others under minimal conditions. *Emotion*, **8**, 479–493.

Bond, C.F., Berry, D.S., and Omar, A. (1994). The kernel of truth in judgments of deceptiveness. *Basic and Applied Social Psychology*, **15**, 523–534.

Boutet, I., Collin, C., and Faubert, J. (2003). Configural face encoding and spatial frequency information. *Perception and Psychophysics*, **65**, 1078–1093.

Brahnam, S. (2005). A computational model of the trait impressions of the face for agent perception and face synthesis. *Artificial Intelligence and Simulation of Behaviour Journal*, **1**, 481–508.

Breiter, H.C., Gollub, R.L., and Weisskoff, R.M. *et al.*(1997). Acute effects of cocaine on human brain activity and emotion. *Neuron*, **19**, 591–611.

Brownlow, S. (1992). Seeing is believing: Facial appearance, credibility, and attitude change. *Journal of Nonverbal Behavior*, **16**, 101–115.

Brownlow, S. and Zebrowitz, L.A. (1990). Facial appearance, gender, and credibility in television commercials. *Journal of Nonverbal Behavior*, **14**, 51–60.

Canli, T., Sivers, H., Whitfield, S.L., Gotlib, I.H., and Gabrieli, J.D.E. (2001). Amygdala response to happy faces as a function of extraversion. *Science*, **296**, 2191.

Carney, D.R., Colvin, C.R., and Hall, J.A. (2007). A thin slice perspective on the accuracy of first impressions. *Journal of Research in Personality*, **41**, 1054–1072.

Carré, J.M. and McCormick, C.M. (2008). In your face: Facial metrics predict aggressive behaviour in the laboratory and in varsity and professional hockey players. *Proceedings of the Royal Society of London: Biological Sciences*, **275**, 2651–2656.

Carré, J.M., McCormick, C.M., and Mondloch, C.J. (2009). Face structure is a reliable cue of aggressive behavior. *Psychological Science*, **20**, 1994–1998.

Chan, S.W., Norbury, R., Goodwin, G.R., and Harmer, C.J. (2009). Risk for depression and neural responses to fearful facial expressions of emotion. *The British Journal of Psychiatry*, **194**, 139–145.

Cloutier, J., Heatherton, T.F., Whalen, P.J., and Kelley, W.M. (2008). Are attractive people.rewarding? Sex differences in the neural substrates of facial attractiveness. *Journal of Cognitive Neuroscience*, **20**, 941–951.

Cloutier, J. and Macrae, C.N. (2007). Who or what are you?: Facial orientation and person construal. *European Journal of Social Psychology*, **37**, 1298–1309.

Cloutier, J., Mason, M.F., and Macrae, C.N. (2005). The perceptual determinants of person construal: reopening the social-cognitive toolbox. *Journal of Personality and Social Psychology*, **88**, 885–894.

Collins, M.A. and Zebrowitz, L.A. (1995). The contributions of appearance to occupational outcomes in civilian and military settings. *Journal of Applied Social Psychology*, **25**, 129–163.

Critchley, H.D. (2004). The human cortex responds to an interoceptive challenge. *Proceedings of the National Academy of Sciences of the United States of America*, **101**, 6333–6334.

Cunningham, W.A., Van Bavel, J.J., and Johnsen, I.R. (2008). Affective flexibility: Evaluative processing goals shape amygdala activity. *Psychological Science*, **19**, 152–160.

Dawes, R.M. (1970). An inequality concerning correlation of composites vs. composites of correlations. *Methodological Note*, **1**, 1–5. Oregon Research Institute.

DeBruine, L.M. (2002). Facial resemblance enhances trust. *Proceedings of the Royal Society B.*, **269**, 1307–1312.

Dipboye, R., Arvey, R., and Terpstra, D. (1977). Sex and physical attractiveness of raters and applicants as determinants of resume evaluations. *Journal of Applied Psychology*, **4**, 288–294.

Dotsch, R., Wigboldus, D.H.J., Langner, O., and van Knippenberg, A. (2008). Ethnic out-group faces are biased in the prejudiced mind. *Psychological Science*, **19**, 978–980.

Eagly, A.H., Ashmore, R.D., Makhijani, M.G., and Longo, L.C. (1991). What is beautiful is good, but...: A meta-analytic review of research on the physical attractiveness stereotype. *Psychological Bulletin*, **110**, 109–128.

Eberhardt, J.L., Davies, P.G., Purdie-Vaughns, V.J., and Johnson, S.L. (2006). Looking deathworthy: Perceived stereotypicality of Black defendants predicts capital-sentencing outcomes. *Psychological Science*, **17**, 383–386.

Engell, A.D., Haxby, J.V., and Todorov, A. (2007). Implicit trustworthiness decisions: Automatic coding of face properties in human amygdala. *Journal of Cognitive Neuroscience*, **19**, 1508–1519.

Fiske, S.T., Cuddy, A.J.C., and Glick, P. (2007). Universal dimensions of social cognition: warmth and competence. *Trends in Cognitive Sciences*, **11**, 77–83.

Fridlund, A.J. (1994). *Human facial expression: An evolutionary view*. San Diego, CA: Academic Press.

Frieze, I.H., Olson, J.E., and Russell, J. (1991). Attractiveness and income for men and women in management. *Journal of Applied Social Psychology*, **21**, 1039–1057.

Gaskill, P.C., Fenton, N., and Porter, J.P. (1927). Judging the intelligence of boys from their photographs. *Journal of Applied Psychology*, **11**, 394–403.

Gosselin, F. and Schyns, P.G. (2001). Bubbles: A technique to reveal the use of information in recognition. *Vision Research*, **41**, 2261–2271.

Gross, A.E. and Crofton, C. (1977). What is good is beautiful. *Sociometry*, **40**, 85–90.

Hall, C.C., Goren, A., Chaiken, S., and Todorov, A. (2009). Shallow cues with deep effects: Trait judgments from faces and voting decisions. In E Borgida, JL Sullivan and CM Federico (eds.) *The Political Psychology of Democratic Citizenship*, pp. 73–99. New York: Oxford University Press.

Hall, J.A., Andrzejewski, S.A., Murphy, N.A., Mast, M.S., and Feinstein, B.A. (2008). Accuracy of judging others' traits and states: Comparing mean levels across tests. *Journal of Research in Personality*, **42**, 1476–1489.

Hamermesh, D. and Biddle, J. (1994). Beauty and the labor market. *The American Economic Review*, **84**, 1174–1194.

Hassin, R. and Trope, Y. (2000). Facing faces: Studies on the cognitive aspects of physiognomy. *Journal of Personality and Social Psychology*, **78**, 837–852.

Hill, T., Lewicki, P., Czyzewska, M., and Schuller, G. (1990). The role of learned inferential encoding rules in the perception of faces: Effects of nonconscious self-perpetuation of a bias. *Journal of Experimental Social Psychology*, **26**, 350–371.

Hollingworth, H.L. (1922). *Judging human character*. New York: D. Appleton and Company.

Hönekopp, J. (2006). Once more: Is beauty in the eye of the beholder? Relative contributions of private and shared taste to judgments of facial attractiveness. *Journal of Experimental Psychology: Human Perception and Performance*, **32**, 199–209.

Hönekopp, J., Becker, B.J., and Oswald, F.L. (2006). The meaning and suitability of various effect sizes for structured rater x ratee designs. *Psychological Methods*, **11**, 72–86.

Johnson, M.K., Kim, J.K., and Risse, G. (1985). Do alcoholic Korsakoff's Syndrome patients acquire affective reactions? *Journal of Experimental Psychology: Learning, Memory, and Cognition*, **11**, 22–36.

Jones, B.C., DeBruine, L.M., Little, A.C., and Feinberg, D.R. (2007). The valence of experiences with faces influences generalized preferences. *Journal of Evolutionary Psychology*, **5**, 119–129.

Kampe, K.K.W., Frith, C.D., Dolan, R.J., and Frith, U. (2001). Reward value of attractiveness and gaze—Making eye contact enhances the appeal of a pleasing face, irrespective of gender. *Nature*, **413**, 589–589.

Keating, C.F. and Bai, D.L. (1986). Children's attributions of social dominance from facial cues. *Child Development*, **57**, 1269–1276.

Keating, C.F., Mazur, A., and Segall, M.H. (1981). A cross-cultural exploration of physiognomic traits of dominance and happiness. *Ethology and Sociobiology*, **2**, 41–48.

Kirsch, P., Esslinger, C., and Chen, Q. *et al.*(2005). Oxytocin modulates neural circuitry for social cognition and fear in humans. *Journal of Neuroscience*, **25**, 11489–11493.

Kniffin, K.M. and Wilson, D.S. (2004). The effect of nonphysical traits on the perception of physical attractiveness. Three naturalistic studies. *Evolution and Human Behavior*, **25**, 88–101.

Kranz, F. and Ishai, A. (2006). Face perception is modulated by sexual preference. *Current Biology*, **16**, 63–68.

Krupp, D.B., DeBruine, L.M., and Barclay, P. (2008). A cue of kinship promotes cooperation for the public good. *Evolution and Human Behavior*, **29**, 49–55.

Laird, D.A. (1927). *The psychology of selecting men* (2nd edition). New York: McGraw-Hill Book Company.

Langlois, J.H., Kalakanis, L., Rubenstein, A.J., Larson, A., Hallam, M., and Smoot, M. (2000). Maxims or myths of beauty? A meta-analytic and theoretical review. *Psychological Bulletin*, **126**, 390–423.

Lewicki, P. (1985). Nonconscious biasing effects of single instances on subsequent judgments. *Journal of Personality and Social Psychology*, **48**, 563–574.

Little, A.C. and Perrett, D.I. (2002). Putting beauty back in the eye of the beholder: evolution and individual differences in face preference. *The Psychologist*, **15**, 28–32.

Little, A.C., Burt, D., Penton-Voak, I.S., and Perrett, D.I. (2001). Self-perceived attractiveness influences human female preferences for sexual dimorphism and symmetry in male faces. *Proceedings of the Royal Society of London B*, **268**, 39–44.

Little, A.C., Burt, D.M., and Perrett, D.I. (2006). What is good is beautiful: face preference reflects desired personality. *Personality and Individual Differences*, **41**, 1107–1118.

Little, A.C., Burriss, R.P., Jones, B.C., and Roberts, S.C. (2007). Facial appearance affects voting decisions. *Evolution and Human Behavior*, **28**, 18–27.

Locher, P., Unger, R., Sociedade, P., and Wahl, J. (1993). At first glance: Accessibility of the physical attractiveness stereotype. *Sex Roles*, **28**, 729–743.

Macrae, C.N., Quinn, K.A., Mason, M.F., and Quadflieg, S. (2005). Understanding others: The face and person construal. *Journal of Personality and Social Psychology*, **89**, 686–695.

Malatesta, C.Z., Fiore, M.J., and Messina, J.J. (1987). Affect, personality, and facial expressive characteristics of older people. *Psychology and Aging*, **2**, 64–69.

Mangini, M.C. and Biederman, I. (2004). Making the ineffable explicit: Estimating the information employed for face classification. *Cognitive Science*, **28**, 209–226.

Martin, D. and Macrae, C.N. (2007). A face with a cue: Exploring the inevitability of person categorization. *European Journal of Social Psychology*, **37**, 806–816.

Mazur, A., Mazur, J., and Keating, C. (1984). Military rank attainment of a West Point class: Effects of cadets' physical features. *American Journal of Sociology*, **90**, 125–150.

Mazur, A. and Mueller, U. (1996). Channel modeling: From West Point cadet to general. *Public Administration Review*, **56**, 191–198.

McArthur, L.Z. and Apatow, K. (1983/4). Impressions of babyfaced adults. *Social Cognition*, **2**, 315–342.

Montepare, J.M. and Dobish, H. (2003). The contribution of emotion perceptions and their overgeneralizations to trait impressions. *Journal of Nonverbal Behavior*, **27**, 237–254.

Montepare, J.M. and Zebrowitz, L.A. (1998). Person perception comes of age: The salience and significance of age in social judgments. *Advances in Experimental Social Psychology*, **30**, 93–161.

Mueller, U. and Mazur, A. (1996). Facial dominance of West Point cadets as a predictor of later military rank. *Social Forces*, **74**, 823–850.

Nisbett, R.E. and Wilson, T.D. (1977). The halo effect: Evidence for unconscious alteration of judgments. *Journal of Personality and Social Psychology*, **35**, 250–256.

O'Doherty, J.P., Deichmann, R., Critchley, H.D., and Dolan, R.J. (2002). Neural responses during anticipation of a primary taste reward. *Neuron*, **33**, 815–826.

O'Doherty, J., Kringelbach, M.L., Rolls, E.T., Hornak, J., and Andrews, C. (2001). Abstract reward and punishment representations in the human orbitofrontal cortex. *Nature Neuroscience*, **4**, 95–102.

O'Doherty, J., Winston, J., Critchley, H., Perrett, D., Burt, D.M., and Dolan, R.J. (2003). Beauty in a smile: The role of medial orbitofrontal cortex in facial attractiveness. *Neuropsychologia*, **41**, 147–155.

Olivola, C.Y. and Todorov, A. (2010). Elected in 100 milliseconds: Appearance-based trait inferences and voting. *Journal of Nonverbal Behavior*, **34**, 83–110.

Olson, I.R. and Marshuetz, C. (2005). Facial attractiveness is appraised in a glance. *Emotion*, **5**, 498–502.

Oosterhof, N.N. and Todorov, A. (2008). The functional basis of face evaluation. *Proceedings of the National Academy of Sciences of the USA*, **105**, 11087–11092.

Oosterhof, N.N. and Todorov, A. (2009). Shared perceptual basis of emotional expressions and trustworthiness impressions from faces. *Emotion*, **9**, 128–133.

Pashos, A. and Niemitz, C. (2003). Results of an explorative empirical study on human mating in Germany: Handsome men, not high-status men, succeed in courtship. *Anthropologischer Anzeiger*, **61**, 331–341.

Paunonen, S.V. (2006). You are honest and therefore I like you and find you attractive. *Journal of Research in Personality*, **40**, 237–249.

Penton-Voak, I.S., Pound, N., Little, A.C., and Perrett, D.I. (2006). Personality judgments from natural and composite facial images: More evidence for a "kernel of truth" in social perception. *Social Cognition*, **24**, 607–640.

Perrett, D.I., Lee, K.J., and Penton-Voak, I. *et al.* (1998). Effects of sexual dimorphism on facial attractiveness. *Nature*, **394**, 884–887.

Pintner, R. (1918). Intelligence as estimated from photographs. *Psychological Review*, **25**, 286–296.

Poldrack, R.A. (2006). Can cognitive processes be inferred from neuroimaging data? *Trends in Cognitive Sciences*, **10**, 59–63.

Pound, N., Penton-Voak, I.S., and Brown, W.M. (2007). Facial symmetry is positively associated with self-reported extraversion. *Personality and Individual Differences*, **43**, 1572–1582.

Pound, N., Penton-Voak, I.S., and Surridge, A.K. (2008). Testosterone responses to competition in men are related to facial masculinity. *Proceedings of the Royal Society of London: Biological Sciences*, **276**, 153–159.

Poutvaara, P., Jordahl, H., and Berggren, N. (2009). Faces of politicians: Babyfacedness predicts inferred competence but not electoral success. *Journal of Experimental Social Psychology*, **45**, 1132–1135.

Quinn, K.A. and Macrae, C.N. (2005). Categorizing others: The dynamics of person construal. *Journal of Personality and Social Psychology*, **88**, 467–479.

Rhodes, G. (2006). The evolutionary psychology of facial beauty. *Annual Review of Psychology*, **57**, 199–226.

Rhodes, G., Simmons, L.W., and Peters, M. (2005). Attractiveness and sexual behavior: Does attractiveness enhance mating success? *Evolution and Human Behavior*, **26**, 186–201.

Rule, N.O. and Ambady, N. (2008). Brief exposures: Male sexual orientation is accurately perceived at 50 ms. *Journal of Experimental Social Psychology*, **44**, 1100–1105.

Said, C.P., Baron, S., and Todorov, A. (2009a). Nonlinear amygdala response to face trustworthiness: Contributions of high and low spatial frequency information. *Journal of Cognitive Neuroscience*, **21(3)**, 519–528.

Said, C.P., Sebe, N., and Todorov, A. (2009b). Structural resemblance to emotional expressions predicts evaluation of emotionally neutral faces. *Emotion*, **9**, 260–264.

Santos, I.M. and Young, A.W. (2008). Effects of inversion and negation on social inferences from faces. *Perception*, **37**, 1061–1078.

Sarter, M., Bernston, G.G., and Cacioppo, J.T. (1996). Brain imaging and cognitive neuroscience: Toward strong inference in attributing function to structure. *American Psychologist*, **51**, 13–21.

Schultz, W. (2000). Multiple reward signals in the brain. *Nature Reviews Neuroscience,* **1**, 199–207.

Schyns, P.G., Bonnar, L., and Gosselin, F. (2002). Show me the features! Understanding recognition from the use of visual information. *Psychological Science,* **13**, 402–409.

Schyns, P.G., Gosselin, F., and Smith, M.L. (2008). Information processing algorithms in the brain. *Trends in Cognitive Sciences,* **13**, 20–26.

Secord, P.F. (1958). Facial features and inference processes in interpersonal perception. In R. Tagiuri and L. Petrullo (eds.) Person perception and interpersonal behavior, pp. 300–315. Stanford, CA: Stanford University Press.

Sell, A., Cosmides, L., Tooby, J., Sznycer, D., von Rueden, C., and Gurven, M. (2009). Human adaptations for the visual assessment of strength and fighting ability from the body and face. *Proceedings of the Royal Society of London: Biological Sciences,* **276**, 575–584.

Shallice, T. (1988). *From neuropsychology to mental structure.* Cambridge: Cambridge University Press.

Shepherd, J. (1989). The face and social attribution. In A. W. Young and H. D. Ellis (eds.),*Handbook of Research on Face Processing,* pp. 289–320. Elsevier Science Publishers.

Singular Inversions. (2006). *FaceGen 3.1 Ful l SDK Documentation.* http://facegen.com

Smith, M., Cottrell, G., Gosselin, F., and Schyns, P.G. (2005). Transmitting and decoding facial expressions of emotions. *Psychological Science,* **16**, 184–189.

Snyder, M., Tanke, E.D., and Berscheid, E. (1977). Social perception and interpersonal behavior: On the self-fulfilling nature of social stereotypes. *Journal of Personality and Social Psychology,* **35**, 656–666.

Teves, D., Videen, T.O., Cryer, P.E., and Powers, W.J. (2004). Activation of human medial prefrontal cortex during autonomic responses to hypoglycemia. *Proceedings of the National Academy of Sciences of the United States of America,* **101**, 6217–6221.

Theodoridou, A., Rowe, A.C., Penton-Voak, I.S., and Rogers, P.J. (2009). Oxytocin and social perception: Oxytocin increases perceived facial trustworthiness and attractiveness. *Hormones and Behavior,* **56**, 128–132.

Thornhill, R. and Gangestad, S.W. (1993). Human facial beauty: Averageness, symmetry and parasitic resistance. *Human Nature,* **4**, 237–269.

Todorov, A. (2008). Evaluating faces on trustworthiness: An extension of systems for recognition of emotions signaling approach/avoidance behaviors. In A. Kingstone and M. Miller (eds.) The Year in Cognitive Neuroscience 2008, Annals of the New York Academy of Sciences, **1124**, 208–224.

Todorov, A. (2009). On the richness and limitations of dimensional models of social perception. *Behavioral and Brain Sciences,* **32**, 402–403.

Todorov, A. and Duchaine, B. (2008). Reading trustworthiness in faces without recognizing faces. *Cognitive Neuropsychology,* **25**, 395–410.

Todorov, A. and Engell, A. (2008). The role of the amygdala in implicit evaluation of emotionally neutral faces. *Social, Cognitive, and Affective Neuroscience,* **3**, 303–312.

Todorov, A., Loehr, V., and Oosterhof, N.N. (2010). The obligatory nature of holistic processing of faces in social judgments. *Perception,* **39**, 514–532.

Todorov, A. and Olson, I. (2008). Robust learning of affective trait associations with faces when the hippocampus is damaged, but not when the amygdala and temporal pole are damaged. *Social, Cognitive, and Affective Neuroscience,* **3**, 195–203.

Todorov, A. and Uleman, J.S. (2002). Spontaneous trait inferences are bound to actor's faces: Evidence from a false recognition paradigm. *Journal of Personality and Social Psychology,* **83**, 1051–1065.

Todorov, A. and Uleman, J.S. (2003). The efficiency of binding spontaneous trait inferences to actor's faces. *Journal of Experimental Social Psychology,* **39**, 549–562.

Todorov, A. and Uleman, J.S. (2004). The person reference process in spontaneous trait inferences. *Journal of Personality and Social Psychology,* **87**, 482–493.

Todorov, A., Mandisodza, A.N., Goren A., and Hall C.C. (2005). Inferences of competence from faces predict election outcomes. *Science,* **308**, 1623–1626.

Todorov, A., Gobbini, M.I., Evans, K.K., and Haxby, J.V. (2007). Spontaneous retrieval of affective person knowledge in face perception. *Neuropsychologia*, **45**, 163–173.

Todorov, A., Baron, S., and Oosterhof, N.N. (2008a). Evaluating face trustworthiness: A model based approach. *Social, Cognitive, and Affective Neuroscience*, **3**, 119–127.

Todorov, A., Said, C.P., Engell, A.D., and Oosterhof, N.N. (2008b). Understanding evaluation of faces on social dimensions. *Trends in Cognitive Sciences*, **12**, 455–460.

Todorov, A., Pakrashi, M., and Oosterhof, N.N. (2009). Evaluating faces on trustworthiness after minimal time exposure. *Social Cognition*, **27**, 813–833.

Verdonck, A., Gaethofs, M., Carels, C., and de Zegner, F. (1999). Effect of low-dose testosterone treatment on craniofacial growth in boys with delayed puberty. *European Journal of Orthodontics*, **21**, 137–143.

Vigil, J.M. (2009). A sociorelational framework of sex differences in the expression of emotion. *Behavioral and Brain Sciences*, **32**, 1–54.

Wiggins, J.S. (1979). A psychological taxonomy of trait descriptive terms: The interpersonal domain. *Journal of Personality and Social Psychology*, **37**, 395–412.

Wiggins, J.S., Philips, N., and Trapnell, P. (1989). Circular reasoning about interpersonal behavior: Evidence concerning some untested assumptions underlying diagnostic classification. *Journal of Personality and Social Psychology*, **56**, 296–305.

Willis, J. and Todorov, A. (2006). First impressions: Making up your mind after 100 ms exposure to a face. *Psychological Science*, **17**, 592–598.

Winston, J., O'Doherty, J., Kilner, J.M., Perrett, D.I., and Dolan, R.J. (2007). Brain systems for assessing facial attractiveness, *Neuropsychologia*, **45**, 195–206.

Winston, J., Strange, B., O'Doherty, J., and Dolan, R. (2002). Automatic and intentional brain responses during evaluation of trustworthiness of faces. *Nature Neuroscience*, **5**, 277–283.

Zebrowitz, L.A. (1999). *Reading faces: Window to the soul?* Boulder, CO: Westview Press.

Zebrowitz, L.A. (2004). The origins of first impressions. *Journal of Cultural and Evolutionary Psychology*, **2**, 93–108.

Zebrowitz, L.A. and Collins, M.A. (1997). Accurate social perception at zero acquaintance: The affordances of a Gibsonian approach. *Personality and Social Psychology Review*, **1**, 204–223.

Zebrowitz, L.A. and McDonald, S.M. (1991). The impact of litigants' babyfaceness and attractiveness on adjudications in small claims courts. *Law and Behavior*, **15**, 603–623.

Zebrowitz, L.A. and Rhodes, G. (2004). Sensitivity to "bad genes" and the anomalous face overgeneralization effect: Cue validity, cue utilization, and accuracy in judging intelligence and health. *Journal of Nonverbal Behavior*, **28**, 167–185.

Zebrowitz, L.A., Voinescu, L., and Collins, M.A. (1996). "Wide-eyed" and "crooked-faced": Determinants of perceived and real honesty across the life span. *Personality and Social Psychology Bulletin*, **22**, 1258–1269.

Zebrowitz, L.A., Andreoletti, C., Collins, M.A., Lee, S.Y., and Blumenthal, J. (1998a). Bright, bad, babyfaced boys: Appearance stereotypes do not always yield self-fulfilling prophecy effects. *Journal of Personality and Social Psychology*, **75**, 1300–1320.

Zebrowitz, L.A., Collins, M.A., and Dutta, R. (1998b). The relationship between appearance personality across the life span. *Personality and Social Psychology Bulletin*, **24**, 736–749.

Zebrowitz, L.A., Hall, J.A., Murphy, N.A., and Rhodes, G. (2002). Looking smart and looking good: Facial cues to intelligence and their origins. *Personality and Social Psychology Bulletin*, **28**, 238–249.

Zebrowitz, L.A., Fellous, J.M., Mignault, A., and Andreoletti, C. (2003). Trait impressions as overgeneralized responses to adaptively significant facial qualities: Evidence from connectionist modeling. *Personality and Social Psychology Review*, **7**, 194–215.